REMARKS

35 U.S.C. §102(b)

Applicants assert that the invention as claimed is not anticipated by Terao, nor by Davis or Yamaoka.

The invention as claimed in independent Claim 1 discloses a vibration isolation, position actuation device comprising a pneumatic actuator, a pressure servo-valve, an air pressure supply, a coil and magnet, a state variable sensor, and a control unit wherein the pressure servo-valve accepts an input command signal and modulates the air pressure supply which is applied to the pneumatic actuator, wherein the state variable sensor measures a state variable of the pneumatic actuator resulting from the applied modulated air pressure supply, wherein the control unit determines the error existing in the measured state variable relative to the command signal, and wherein the control unit modulates electrical current applied to the coil such that a magnetic force is applied to the pneumatic actuator by the magnet in such proportion to negate the measured error in the state variable of the pneumatic actuator.

The Terao device is not an isolator, but only an actuator; it is an actuator comprising a ball screw operating in mechanically conjoined position with an air piston. The Terao device does not incorporate a magnet and coil such that it may apply a magnetic force to a pneumatic actuator. Terao, instead of a magnet and coil, incorporates a ball screw and the ball screw applies an indeterminate mechanical force to the piston based on the desired workpiece position. The present invention applies a magnetic force in such proportion to negate the measured error in the commanded state variable of the

pneumatic actuator, this state variable being inclusive of the force output of the actuator. For these distinct differences, Applicants assert the present invention is not anticipated by Terao.

35 U.S.C. §103(a)

Applicants assert that the invention as claimed in the independent Claim 1 is not rendered obvious by the prior art and not by Terao, by Davis or by Yamaoka, whether alone or in combination.

The invention as claimed in independent Claim 1 discloses a vibration isolation, position actuation device comprising a pneumatic actuator, a pressure servo-valve, an air pressure supply, a coil and magnet, a state variable sensor, and a control unit wherein the pressure servo-valve accepts an input command signal and modulates the air pressure supply which is applied to the pneumatic actuator, wherein the state variable sensor measures a state variable of the pneumatic actuator resulting from the applied modulated air pressure supply, wherein the control unit determines the error existing in the measured state variable relative to the command signal, and wherein the control unit modulates electrical current applied to the coil such that a magnetic force is applied to the pneumatic actuator by the magnet in such proportion to negate the measured error in the state variable of the pneumatic actuator.

Again as stated, the Terao device is not an isolator, but only an actuator; it is a position actuator comprising a ball screw operating in mechanically conjoined position with an air piston. The Terao device cannot control the force applied to the payload to provide vibration isolation as well as position actuation.

The Terao device does not incorporate a magnet and coil such that it may apply an error correcting magnetic force to a pneumatic actuator, as does the present invention. The Terao device cannot make the applied dynamic force as large or as small as necessary to effectively isolate the workpiece or payload from vibrations in the mounting base of the device, as does the present invention.

Terao, instead of a magnet and coil, incorporates a ball screw and the ball screw applies an indeterminate mechanical force to the piston based on the desired workpiece position. The air piston initially positions and supports the static load of the table and any attached workpiece. The ballscrew then provides the final positioning of the workpiece. The Terao device, in using the ball screw to engage and provide final position of the piston and workpiece, suffers from the inherent stiffness of, and inability to backdrive the ballscrew. These attributes coupled with the low dynamic force response of the drive motors and pulleys prevent the Terao device from providing any significant vibration isolation capability.

Because of these features of the Terao device and to its significant limitation, the Terao device positions its workpiece regardless of the body accelerations that may exist on the workpiece or the dynamic displacement disturbances at the base of support for the device. Because of the stiffness of the load path through the ball screw, the Terao device transmits whatever dynamic displacement disturbances the base experiences onto the workpiece.

The present invention provides vibration isolation at high frequency and also provides position control via force control through the error correcting application of a magnetic force of potentially zero stiffness directly to the pneumatic actuator portion of

the device. This has not been done before and the combination is not obvious. Within the broad flexibility of the present invention, as claimed in independent Claim 1, a variety of actuation state variables may be controlled in conjunction with broadband vibration isolation. In a preferred embodiment the present invention effects a force generation device. Its stiffness can be made as soft as desired simply by configuration of the force feedback loop managed by the control unit. At low frequency, it can have a stiffness approaching zero simply by commanding a constant force equal to the external static load. The Terao device has no such capability, and it does not teach or suggest such ability alone or in combination with any other device of the prior art.

The Terao device effects a static position control device whereas the presently disclosed invention effects a vibration isolation and dynamic force (or other state variable) control device. The Terao device, through use of the ballscrew accomplishes refined position control on the pneumatic cylinder, but it has very little bandwidth, i.e. it could not produce a position output that would accurately track an input signal if a command waveform called for it to move back and forth over a significant distance at a rate of more than, at most, a few cycles per second. The Terao device does not teach or disclose application of a magnetic force to the pneumatic actuator in such proportion to negate the measured error in the state variable of the pneumatic actuator.

The Terao device neither discloses the particular elements of the invention as claimed in independent Claim 1 nor does it teach or suggest the combination of the elements and resulting advantages of the disclosed invention. Particularly, the presence of the electric motor driven ballscrew in the Terao device is not equivalent in elemental concept, application nor capability to the application of a magnetic force directly to the

pneumatic actuator via a coil and magnet through the modulation of an electric current applied to the coil. The ballscrew imparts substantial stiffness that prevents vibration isolation, and further the motor and drive add significant effective inertia to the device.

The Examiner asserts that Davis and Terao combine to render the present invention obvious. The Davis device utilizes an electromagnetic actuator to vary the pressure of the damping fluid used within an otherwise passive damping mechanism. The Davis device provides some modest position actuation capability through the modulation and compression of the damping fluid within the device, and the actuation motion is accommodated mechanically by and limited to the slotted screw holes in the connection of the device's housing elements.

The Davis device does not disclose a pneumatic actuator nor actuation means of any significant stroke relative to the size of the device. Large displacement actuation is not available within the concept of the device since actuation is only gained through the fluid pressurization and modest fluid movement offered by the internal electromagnetic actuator, and the possible motion available by this approach is limited by the D-shaped flexure piece which forms essential part of the damping fluid chamber. Further, because of the need to limit the size and stiffness of the D-shaped flexure so to provide lower frequency vibration isolation and to limit the required fluid pressure change during actuation, the load carrying capability of the Davis device is limited by the strength of this D-shaped spring.

The electromagnetic actuator built into the Davis device does control the isolator to the extent that damping is modulated by the change in damping fluid pressure and secondarily to the degree that modest position control is effected through this change in

damping fluid pressure. However, the mere utilization of an electromagnetic actuator within an isolator device does not make obvious the invention as claimed in independent Claim 1.

Of particular note, device actuation state variable control, and particularly overall device output force control, is not provided by the Davis device and Davis is not instructive on how such control could be implemented onto the Terao device. It is accepted by Applicants as obvious that an electromagnetic actuator can be used to vary the position of one component relative to another in precise and broad frequency fashion. Applicants assert, however, that it is not obvious how one employs the characteristics of an electromagnetic actuator onto the Terao device to obtain the present invention or equivalent capabilities of the present invention. Applicants further assert that an electromagnetic actuator and motor driven ballscrew cannot serve as equivalents within vibration isolation devices, and therefore substitution of one for another would not be obvious. It is further not apparent how the vibration isolation capability of Davis could be imparted to the actuation ability of Terao.

The presently claimed invention provides significantly larger payload carrying capability, higher accuracy dynamic position actuation capability, as well as significant broadband vibration damping and isolation ability beyond the state of the prior art. The presently claimed invention can track a force command at rates of 20-40 cycles per second. The Davis device discloses a passive damping device that relies on arc shaped mechanical spring elements to support the isolated payload, thereby significantly limiting its load carrying ability. Further, the position actuation capability of Davis is limited to the modest loads and strokes afforded by the electromagnetic actuation portion of the

device. The Terao device claims no isolation ability, and inherently has little effective vibration isolation capability, and incorporation of isolation features of Davis is not obvious. The Applicants assert that beyond the conceptual distinctions drawn, that the presently claimed invention as claimed in independent Claim 1 is non-obvious based on its distinct and marked improvement in performance relative to devices of the prior art.

Yamaoka discloses an electromagnetic strut and discloses nothing addressed to vibration isolation. The Yamaoka device uses electromagnetics to generate the entire force developed by the device and incorporates no passive means for transmitting force from one end of the device to the other. Yamaoka does not, as does the presently claimed invention, disclose a pneumatic actuator or a pressure servo-valve, or an air pressure supply along with a coil and magnet where a magnetic force is applied in such proportion to negate the measured error in the pneumatic actuator.

Because of the above described distinct, novel, and non-obvious differences of the present invention relative to Terao, Davis, and Yamaoka, and because of the significant performance advantages and improvements provided by the present invention relative to the prior art, Applicants assert that the present invention as claimed in independent Claim 1 is not obvious in light of the prior art and is not obvious in light of Terao, Davis, and Yamaoka when considered alone or in combination.

CONCLUSION

For the above reasons, the present invention as claimed in the original and unamended independent Claim 1 is not anticipated by the prior art and is not obvious in

light of the prior art. Dependent claims 2-6 remain allowable as being dependent upon allowable base Claim 1.

Accordingly, Applicants respectfully submit that all the claims as originally submitted are in condition for allowance, and such action is earnestly solicited.

Respectfully submitted,

8/28/2004

Rick G. Brewster

USPTO Reg. No. 35,077